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ABSTRACT

NASA CONNECT is an annual series of free integrated mathematics, science, and technology instructional distance learning programs for students in grades 5-8. Each program has three components: (1) a 30-minute television broadcast which can be viewed live or taped for later use; (2) an interactive Web activity that allows teachers to integrate technology into the classroom setting; and (3) a lesson guide. This packet contains the lesson guide that accompanies the first program of the 2001-2002 series. In this learning unit on measurement, ratios, and graphing, students learn about NASA's Aviation Safety Program and how engineers test aircraft at extreme angles in wind tunnels to make sure they remain a safe form of transportation for all future air travelers. Students also learn about NASA FutureFlight Central, a virtual facility that simulates our nation's airports in real time, allowing air traffic controllers, pilots, and airport personnel to interact with each other and test new technologies. Students observe NASA engineers using mathematics to predict airplane behavior and analyze data. By conducting hands-on and Web activities, students make connections between NASA research and the mathematics, science, and technology they learn in the classroom. The lesson guide contains a program overview, a hands-on activity on air traffic safety with complete student and teacher materials, a description of an instructional technology activity that relates to a multimedia CD-ROM and other interactive instructional technology, and resources relating to aviation and other aspects of the activities. The packet also includes a series overview complete with descriptions of the instructional design, the teaching strategy used in the series, and NASA resources for educators. (PVD)

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National Aeronautics and Space Administration

Langley Research Center
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Educational Product
Educators | Grades 5-8

ED 459 064

NASA CONNECT

Measurement, Ratios, and Graphing: Safety First

A Lesson Guide with Activities in Mathematics, Science, and Technology

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Measurement, Ratios, and Graphing: Safety First is available in electronic format through NASA Spacelink - one of NASA's electronic resources specifically developed for the educational community. This publication and other educational products may be accessed at the following address: **http://spacelink.nasa.gov/products**

A PDF version of the lesson guide for NASA CONNECT can be found at the NASA CONNECT web site: **http://connect.larc.nasa.gov**

NASA CONNECT

Measurement, Ratios, and Graphing: Safety First

A Lesson Guide with Activities in Mathematics, Science, and Technology

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Program Overview

SUMMARY AND OBJECTIVES

In *Measurement, Ratios, and Graphing: Safety First,* students will learn about NASA's Aviation Safety Program and how engineers are testing aircraft at extreme angles in wind tunnels to make sure they remain a safe form of transportation for all future air travelers. They will also learn about NASA FutureFlight Central, a virtual facility that simulates our nation's airports in real time, allowing air traffic controllers, pilots, and airport personnel to interact with each other and test new technologies. Students will observe NASA engineers using mathematics to predict airplane behavior and to analyze data. By conducting hands-on and web activities, students will make connections between NASA research and the mathematics, science, and technology they learn in their classrooms.

STUDENT INVOLVEMENT

Cue Card Questions

Norbert, NASA CONNECT's animated co-host, poses questions throughout the broadcast. These questions direct the instruction and encourage students to think about the concepts being presented. When viewing a videotaped version of NASA CONNECT, educators have the option to use Norbert's Pause, which gives students an opportunity to reflect and record their answers on the Cue Cards (p. 15). Norbert appears with a remote to indicate an appropriate time to pause the videotape and discuss the answers to the questions.

Hands-On Activity

"In the Safety Zone," the hands-on activity, is teacher-created and is aligned with the National Council of Teachers of Mathematics (NCTM) standards, the National Science Education (NSE) standards, the International Technology Education Association (ITEA) standards, and the National Educational Technology (NET) standards. Students will assume the role of an air traffic controller (ATC) to safely and efficiently guide aircraft to their destinations. Through plotting, measuring, and calculating, students will experience the stressful job of an ATC.

Instructional Technology Activity

Gate to Gate, the instructional technology activity, is aligned with the National Council of Teachers of Mathematics (NCTM) standards, the National Science Education (NSE) standards, the International Technology Education Association (ITEA) standards, and the National Educational Technology (NET) standards. This multimedia CD-ROM takes students behind the scenes to meet the people who manage air traffic and highlights some of the tools they use everyday. Students will navigate through the phases of a flight from San Francisco to New York and become familiar with the air traffic management facilities that monitor their flight. *Gate to Gate* is available through NASA Central Operation of Resources for Educators, **http://core.nasa.gov**.

RESOURCES

Teacher and student resources (p. 21) support, enhance, and extend the NASA CONNECT program. Books, periodicals, pamphlets, and web sites provide teachers and students with background information and extensions. In addition to the resources listed in this lesson guide, the NASA CONNECT web site, **http://connect.larc.nasa.gov**, offers on-line resources for teachers, students, and parents. Teachers who would like to get the most from the NASA CONNECT web site can visit the "Lab Manager," located in "Dan's Domain," **http://connect.larc.nasa.gov/dansdomain.html**.

Hands-On Activity

BACKGROUND

The Air Traffic Control System is run by the Federal Aviation Administration (FAA) as an agency of the U.S. Department of Transportation. The system's primary purpose is to maintain safe separation of aricraft throughout the U.S. and to keep air traffic flowing as efficiently as possible in an orderly fashion.

Air traffic controllers coordinate the movement of aircraft to make certain that they stay a safe distance apart. Their immediate concern is safety, but controllers must direct aircraft efficiently to minimize delays.

Although air traffic controllers monitor all aircraft traveling through any airspace, their main responsibility is to organize the flow of aircraft in and out of airports. Relying on radar and visual observation, they closely monitor each plane to ensure a safe distance between all aircraft and to guide pilots to a safe landing. Controllers also keep pilots informed about changes in weather conditions such as wind shear. Wind shear is a sudden change in the velocity or direction of the wind that can cause the pilot to lose control of the aircraft.

Every minute hundreds of commercial aircraft begin flights that follow a common profile. The flight begins in preflight when weather information is obtained and a flight plan is filed. After the tower gives departure clearance, the aircraft leaves the gate, and the pilot receives instructions from the Ground Controller, who is responsible for all ground movement around the airport. The aircraft then taxis towards the takeoff runway. After "cleared for takeoff" is issued by the Local Controller, a person responsible for takeoff and landing clearance, the aircraft lifts off the runway. Shortly after takeoff, the pilot is instructed to change radio frequency and contact Departure Control or Terminal Radar Approach CONtrol (TRACON). During this phase, the aircraft is routed away from the airport by the Departure Controller, who is responsible for routing air traffic immediately upon takeoff by using an assigned heading with a climb clearance to a new altitude.

After departure, the aircraft is transferred to an en route controller. There are 21 en route control centers located around the country. In these centers, controllers work in teams of up to three members, depending on the amount of air traffic. Each team is responsible for a section of the center's airspace. These controllers are in charge of the aircraft between airports.

As an aircraft approaches a team's airspace, the radar controller accepts responsibility from the previous controlling unit. The controller also delegates responsibility for the aircraft to the next controlling unit when the aircraft leaves a team's airspace.

The radar controller observes the aircraft in the team's airspace on radar and communicates with the pilots when necessary. Radar controllers warn pilots about nearby aircraft, bad weather conditions, unusual terrain, and other potential hazards. Through team coordination, the aircraft arrives safely at its destination.

In addition to airport towers and en route centers, air traffic controllers also work in flight service centers in more than 100 locations. These flight service specialists help pilots in emergency situations and initiate and coordinate searches for missing or overdue aircraft. They also provide data about the terrain, report weather conditions in the service area, and suggest routes to improve flight safety.

NATIONAL STANDARDS

Mathematics (NCTM) Standards

- Compute fluently and make reasonable estimates.
- Understand patterns, relations, and functions.
- Understand measurable attributes of objects and the units, systems, and processes of measurement.
- Apply appropriate techniques, tools, and formulas to determine measurements.
- Develop and evaluate inferences that are based on data.
- Build new mathematical knowledge through problem solving.
- Apply and adapt a variety of appropriate strategies to solve problems.
- Recognize, use, and learn about mathematics in contexts outside of mathematics.

Science (NSE) Standards

- Unifying Concepts and Processes
  Systems, order, and organization
  Change, constancy, and measurement
- Science as Inquiry
  Understanding about scientific inquiry
- Science and Technology
  Abilities of technological design
- Science in Personal and Social Perspectives
  Personal health
  Populations, resources, and environments
  Natural hazards
  Risks and benefits
- Science and technology in society

Technology (ITEA) Standards

The Nature of Technology

- Develop an understanding of the characteristics and scope of technology.

Technology and Society

- Develop an understanding of the cultural, social, economic, and political effects of technology.
- Develop an understanding of the role of society in the development and use of technology.

Technology (NET) Standards

- Practice responsible use of technology systems.
- Develop positive attitudes toward technology uses that support lifelong learning collaboration, personal pursuits, and productivity.
- Use technology resources for solving problems and making informed decisions.
- Employ technology in the development of strategies for solving problems in the real world.

INSTRUCTIONAL OBJECTIVES

The student will

- plot initial aircraft coordinates by using a rectangular coordinate system.
- use measurement tools and techniques to determine distance.
- apply ratios to calculate the Air Safety Travel Index.
- calculate initial aircraft distance vs. actual aircraft distance traveled.
- incorporate collaborative problem-solving strategies in a real-life application.

VOCABULARY

air traffic controller (ATC) – a person who coordinates the movement of air traffic to make certain planes stay a safe distance apart and to ensure efficient use of airspace

coordinates – a pair of numbers and/or letters that shows the exact position of a point on a map or graph

flight path – the line connecting the successive positions occupied, or to be occupied, by an aircraft as it moves through air

quadrant – one-fourth section of a coordinate plane

rectangular coordinate plane – a set of lines used to locate points in a plane

runway – a long, level piece of ground with a specially prepared smooth, hard surface on which aircraft take off and land

PREPARING FOR THE ACTIVITY

Student Materials (per 4-student group)

game board
4 calculators
4 Tracking Charts (p. 13)
4 different colored pencils
20 pushpins or sewing pins
4 Safety Rating Cards/Game Constraints (p. 14)
corrugated cardboard (44 cm x 56 cm)
4 metric rulers
4 Flight Plans (p. 12)
pre-cut game pieces

Teacher Materials

stopwatch or timer
Aircraft and Storm Game Pieces (p. 16)
clear tape

Time

Discussion of the activity (reviewing constraints and parameters) ..... 15 min
Playing the game ..... 40 min

Focus Questions

1. What is the job of an Air Traffic Controller (ATC)?
2. Why is aircraft safety important to the ATC?
3. How does an ATC keep track of multiple aircraft in a region at one time?
4. How does an ATC assign the landing order of multiple aircraft?

Advance Preparation

For each group:

1. Copy the game board and assemble using clear tape.
2. Cut out the Aircraft and Storm Game Pieces (p. 16).

THE ACTIVITY

Step 1: Introducing the Activity

A. Organize students into groups of four.

B. Distribute a game board and the necessary materials to each group.

C. Provide each group member with

- a Flight Plan (p. 12) to record the landing times.
- a Tracking Chart (p. 13) to track the progress of the assigned planes.
- a Safety Rating Card (p. 14) to keep track of the total points earned, and the Game Constraints (p. 14).

Note: Be sure to discuss each game card in detail. Remind students of the scoring procedures.

D. Announce: "We will be playing 'In the Safety Zone,' a game of strategy involving Air Traffic Controllers (students) and their ability to safely and efficiently guide aircraft to their destinations. You will be divided into groups of four, and each student or Air Traffic Controller (ATC) will be responsible for three aircraft. Your primary goal is to land each aircraft safely and on time. You will receive points for plotting planes correctly, landing on time, and landing on the correct runway."

E. Have the students plot the initial position for each aircraft on the game board by using the initial aircraft flight coordinates provided in the Flight Plan. Students will use a pushpin or sewing pin, along with the correct aircraft game piece, to mark where each aircraft is initially located.

Note: Each group should know the Flight Plan.

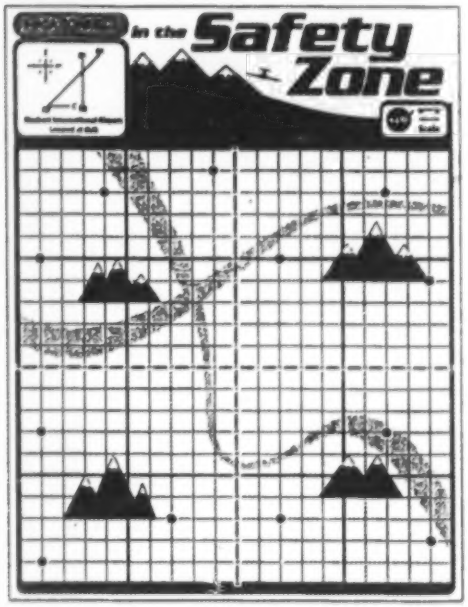


Figure 1

F. Use the answer key (figure 1) to award 1 point for each correctly plotted aircraft. Record the total point value on each group's Student Rating Card.

Note: Make sure students correct any incorrectly plotted aircraft.

G. Assign each group member a quadrant in which to oversee aircraft movement.

Suggestion: Students within each group might want to choose their own quadrant.

I. Announce: "Each ATC is responsible for three aircraft. Record Flight Number, Aircraft Type, and Runway information on the Tracking Chart."

J. Have students choose a colored pencil and color each aircraft game piece to ensure correct tracking.

K. Have each ATC measure the direct distance from each of his assigned aircraft to the airport. Next, have students calculate the direct distance in km using the scale: 2 cm : 5 km. Students round results to the nearest km and record the information on the Tracking Chart (p. 13).

Suggestion: The teacher might want to provide an example problem dealing with ratios and proportions.

L. Announce: "For each minute of play, all aircraft must make 1 move. One move corresponds to 2 cm of linear travel (5 km). Use your metric ruler to verify 2 cm of movement. Remember, an aircraft cannot move backwards on any consecutive move. (See game constraints, p. 14)

M. Announce: "During each minute of play, each ATC must keep track of his aircraft's flight paths using a colored pencil and metric ruler. In addition, after all flight paths have been updated, place a check mark on the Tracking Chart to indicate completion of your aircraft's move."

N. Have students familiarize themselves with the airport layout located at the top of the game board. The entire airport is located on the origin, (0, 0). Please see game constraints for final approach guidelines.

Note: The teacher should draw the airport layout on the chalkboard or overhead projector and explain the landing procedures.

O. Allow groups a few minutes to study the Flight Plan (p. 12), particularly arrival times and runway locations, so that each ATC can plan his landing strategy.

Step 2: Playing the game

A. Control the pace of the game by following the script. All students should work quickly, efficiently, and collaboratively during the game. Remind students they are working as a team and not playing against each other.

B. Set your stopwatch to 0:00.

C. Announce: "We are now ready to begin the game. Flight 322 is taking off from runway B1 and flying to point (-50, 50). Each group should place a pushpin, along with designated aircraft,

at the origin to represent Flight 322."

D. Announce: "Minute 1. Each group now has 1 minute to move each aircraft on the game board 2 cm. Flight 322's first move must be positioned at the point (0, 5) since it is taking off from the south (runway B1)."

Suggestion: For the first several minutes, the teacher might allow an extra 30 seconds so students can complete their moves.

E. Announce: "Minute 2. You have 1 minute to move each aircraft on the game board 2 cm."

F. Announce: "Minute 3. Continue to move aircraft 2 cm."

G. Announce: "Minute 4. Continue to move aircraft 2cm."

H. After the 4th minute, stop the timer and announce: "A thunderstorm is approaching the airport traveling due east at a rate of 5 km/min. The leading edge of the storm is located at (-35, 5) and (-35, -5). Each group needs to place the thunderstorm in the correct position. Minute 5. Continue moving each aircraft 2 cm." Start the timer again.

I. Stop the timer after minute 5 has expired. Announce: "The storm continues to move east at 5 km/min. Flight 932 is taking off from runway A2, heading to the point (-50, -35). Minute 6. Continue moving each aircraft 2 cm. Flight 932's first move must be positioned at the point (-5, -5) before it can change course." Start the timer again.

J. Stop the timer after minute 6 has expired. Announce: "A 737's right engine has caught on fire and caused runway B1 to be temporarily closed to incoming aircraft. The storm continues to move east at 5 km/min. Minute 7. Continue moving each aircraft 2 cm." Start the timer again.

K. Announce: "Minute 8. The storm is still moving east at 5 km/min. Continue moving each aircraft 2 cm."

L. Announce: "Minute 9. Runway B1 has been cleared for takeoffs and landings. The storm continues to advance at 5 km/min. Continue moving each aircraft 2 cm."

M. Stop the timer after minute 9 has expired. Announce: "Flight 1130 is experiencing fuel leakage. Please clear the flight path for an emergency landing. Flight 1130 must land within 7 minutes or no points are awarded for this flight. The storm is still moving due east at 5 km/min. Minute 10. Continue moving each aircraft 2 cm." Start the timer again.

M. Announce: "Minute 11. The storm is still moving east at 5 km/min. Continue moving each aircraft 2 cm."

N. Announce: "Minute 12. The storm is crossing the airport and all takeoffs and landings are delayed until the storm clears. Continue moving each aircraft 2 cm."

O. Announce: "Minute 13. The storm continues to cross over the airport at 5 km/min, producing heavy downpours and severe lightning. Airport is still temporarily closed. Continue moving each aircraft 2 cm."

P. Announce: "Minute 14. The storm continues to cross over the airport at 5 km/min. Airport is still temporarily closed as the storm moves through the area. Continue moving each aircraft 2 cm."

Q. Announce: "Minute 15. The storm continues to cross over the airport at 5 km/min. Airport is still temporarily closed as the storm heads out of the area. Continue moving each aircraft 2 cm."

R. Announce: "Minute 16. The storm has dissipated and the airport is now clear for takeoffs and landings. Continue moving each aircraft 2 cm."

S. Announce: "Minute 17. Continue moving each aircraft 2 cm."

T. Announce: "Minute 18. Mechanical problems have caused runways B1 and B2 to be closed for the next 3 minutes. Continue moving each aircraft 2 cm."

U. Announce. "Minute 19. Continue moving each aircraft 2 cm."

V. Announce: "Minute 20. Continue moving each aircraft 2 cm."

W. Announce: "Minute 21. Runways B1 and B2 are

open for takeoffs and landings. Continue moving each aircraft 2 cm."

X. Continue to announce each minute until all aircraft have landed.

Step 3: Scoring the game

A. Score 10 points for aircraft landed on time, subtract 1 point for each minute ahead or behind schedule, and subtract 5 penalty points for each aircraft coming in on the wrong runway.

B. Each ATC responsible for tracking Flight 322 or Flight 932 receives 2 bonus points if each flight reaches its destination before the game is over (4 point maximum). Have students record bonus points under Team Score on the Safety Rating Card (p. 14).

Step 4: Distance and Accuracy Calculations

A. Have students determine the Air Safety Travel Index (ASTI) by calculating the percentage using the ratio of team points divided by total possible points (132). Write the percentage on the Safety Rating Card.

B. Have students complete the Tracking Chart (p. 13) by calculating the actual linear distance traveled from the aircraft's initial coordinates to the airport by using the equation: 5 (km / min) multiplied by landing time (min).

C. Calculate the difference between the direct distance traveled and the actual distance traveled and record these values on the Tracking Chart.

Step 5: Discussion

A. Analyze the difference between the direct distance traveled and the actual distance traveled. What conclusions can you draw from this discrepancy?

B. Analyze your calculated Air Safety Travel Index (ASTI). The optimum ASTI value is 100%. If your ASTI value is not 100%, what are some variables that affected your ASTI value?

C. Why is communication vital to an Air Traffic Controller?

D. Research indicates that Air Traffic Controlling is of the most challenging and stressful jobs. After having limited experience with directing aircraft, write a paragraph or two commenting on this statement.

E. Air traffic is expected to increase in the future. What challenges will face the next generation of Air Traffic Controllers? What technological advancements will allow the ATCs to perform their job more efficiently?

F. Altitude is not a variable in this activity; however, if it were, how would your strategy change? Would your job as an ATC become easier or harder? Why?

Extensions

1. Invite an Air Traffic Controller to participate in the game with the students. After the game is played, have the ATC lead a discussion on the qualities of a successful ATC.
2. Have the students design their own script and game board for the game.
3. Incorporate advanced topics into the game such as the distance formula, the Pythagorean Theorem, and vectors.

Name:_____

Date:_____

Flight Plan

Aircraft Type	Flight No.	Airline	Departure Point	Flight Coordinates	Arrival Time	Runway	Landing Time	Difference in Times
757	125	Aspen Air	Denver	(10,25)	+7 min.	B1		
MD-80	711	Gamble Air	Las Vegas	(45,20)	+12 min.	B1		
737	625	Cub Tran	Chicago	(35, 40)	+25 min.	B2		
767	780	Green Air	Seattle	(-30, 40)	+18 min.	A1		
Cessna	615	Green Tran	San Francisco	(-45, 25)	+20 min.	C		
DC-9	1058	WWA	Portland	(-5, 45)	+10 min.	B1		
747	239	Dar-Mills Air	Hawaii	(-45, -45)	+27 min.	A2		
777	1214	Fuji	Tokyo	(-40, -15)	+11 min.	A2		
MD-80	1130	Tex-Mex	Mexico	(-15, -35)	+15 min.	B2		
737	347	Saint Airway	New Orleans	(45, -40)	+23 min.	B2		
757	432	Tri-Alpha	Atlanta	(35, -15)	+13 min.	A1		
757	222	Tex-Mex	Houston	(10, -35)	+8 min.	B2		

Tracking Chart

Flight Number			
Aircraft Type			
Runway			
Direct Distance From Airport			
Actual Distance Traveled			
Difference in Kilometers			

Use this grid to help yourself remember if you've moved all your planes! After each minute, check off each plane you have moved.

Minute	Individual Plane Check-Off		
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			

Tracking Chart

Flight Number
Aircraft Type
Runway
Direct Distance From Airport
Actual Distance Traveled
Difference in Kilometers

Use this grid to help yourself remember if you've moved all your planes! After each minute, check off each plane you have moved.

Minute | Individual Plane Check-Off
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

Tracking Chart

Flight Number
Aircraft Type
Runway
Direct Distance From Airport
Actual Distance Traveled
Difference in Kilometers

Use this grid to help yourself remember if you've moved all your planes! After each minute, check off each plane you have moved.

Minute | Individual Plane Check-Off
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

ATC: _____

Quadrant: _____

Safety Ration Card

Individual ATC Score	ATC's Points	Max. Points
Initial Aircraft Setup 1 point for each correctly plotted aircraft	_____	3
Landing Aircraft 10 points possible for each aircraft landed. Subtract 1 point for every minute early or late. Subtract 5 points for a wrong runway landing.	_____	30
Total →	_____	33

Team Score	Points	Max. Points
Quadrant I	_____	↓
Quadrant II	_____	
Quadrant III	_____	
Quadrant IV	_____	132
Bonus Points		
Flight 322	_____	
Flight 932	_____	
Total →	_____	

Air Safety Travel Index (ASTI) Formula

(A/B) * 100 = ASTI

A = Team's Total Points B = Maxium Points

(_____ / 132) * 100 =

1. For each minute of play, aircraft can move 2 cm in any direction except backwards.
2. Aircraft cannot be closer to each other than 2 cm (5 km).
3. To land on Runway C, aircraft must be on the positive x-axis.
4. Runway C is reserved strictly for the Cessna aircraft.
5. To land on Runway B1, aircraft must be on the positive y-axis, and for Runway B2, on the negative y-axis.
6. To land on Runway A1, aircraft must land from the northeast from (5,5) and on Runway A2, from the southwest from (-5, -5).
7. Landing an aircraft on the wrong runway results in a 5-point penalty.
8. No two aircraft can land on the same runway at the same time.
9. Within three minutes of landing, the ATC must announce his intention of landing an aircraft by identifying the flight number and runway.
10. Aircraft flight path must avoid mountains and storms.

Name: _____

Date: _____

John Foster, Senior Research Engineer, NASA Langley Research Center

1. How will NASA contribute to airplane safety in the future?

2. How do NASA engineers use math in their wind tunnel tests?

3. What happens to an airplane when the angle of attack becomes too great?

Nancy Tucker, NASA FutureFlight Central, NASA Ames Research Center

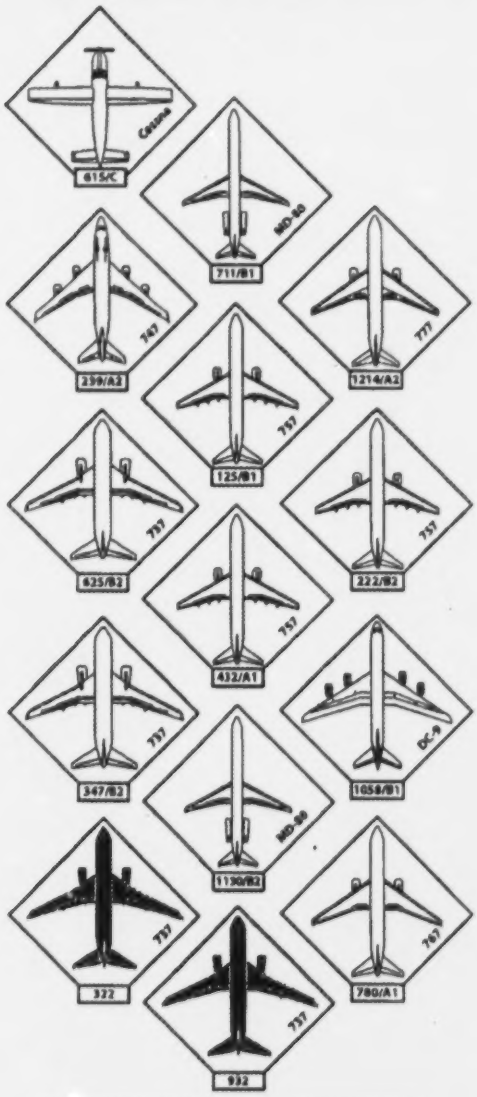
1. Why was NASA FutureFlight Central built?

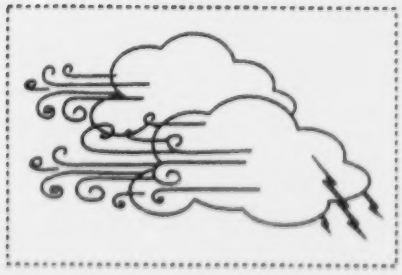
2. How does NASA use technology to simulate airports?

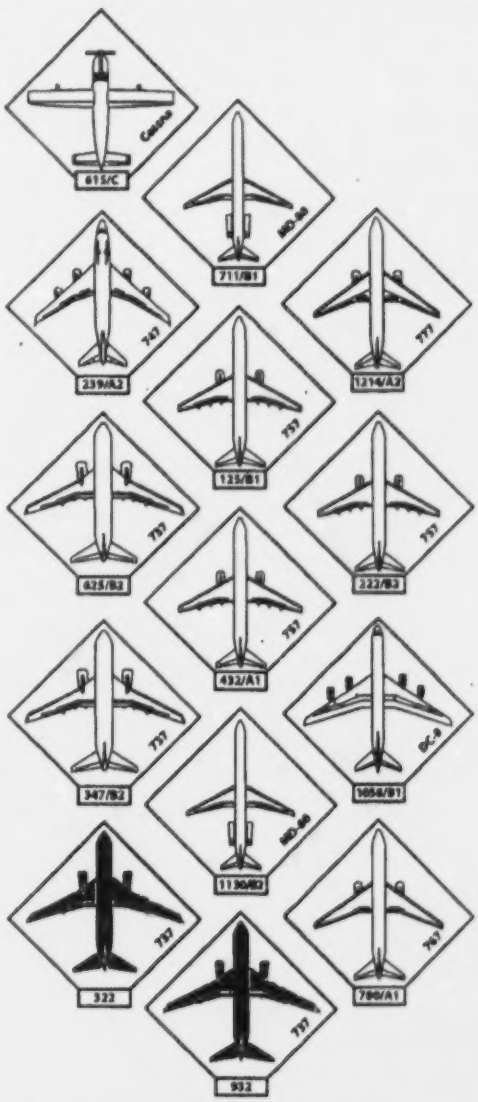
3. Analyzing the graph, what factors do you think influenced the air traffic controllers' responses?

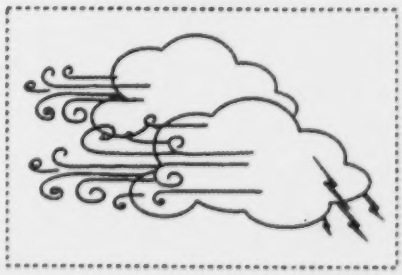
Teacher Materials

AIRCRAFT AND STORM GAME PIECES









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Guest Scientists

John Foster, Senior Research Engineer, NASA Langley Research Center

1. How will NASA contribute to airplane safety in the future?

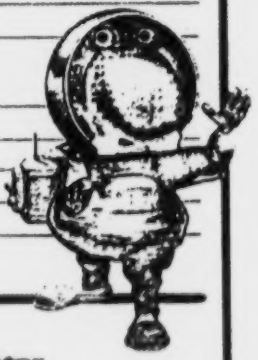
Possible answers: Researchers and engineers involved in NASA's Aviation Safety Program will use wind tunnel tests to study ways to prevent accidents from occuring and will provide new ideas and technologies to airplane manufacturers and airlines.

2. How do NASA engineers use math in their wind tunnel tests?

Possible answers: They use ratios to scale models and solve for different variables. They use graphs to see relationships between data collected in the wind tunnel and to determine if the airplane will be difficult to control.

3. What happens to an airplane when the angle of attack becomes too great?

Possible answers: Aerodynamic stall could occur; the lift coefficient will decrease; the airplane may be difficult to control.



Nancy Tucker, NASA FutureFlight Central, NASA Ames Research Center

1. Why was NASA FutureFlight Central built?

Possible answers: to simulate a full-scale, real-time airport; to allow for interaction between ATC's, pilots and airport personnel; to test new technologies

2. How does NASA use technology to simulate airports?

Possible answers: Computers create a virtual environment of airports from satellite pictures, surveys of the airport from the air, and digitial pictures. Pilots use computers to fly the virtual planes; computers can also simulate weather conditions.

3. Analyzing the graph, what factors do you think influenced the air traffic controllers' responses?

Possible answers: traffic complexity, overall traffic level, aircraft movements, pilot communication, aircraft taxi speeds, gate-related operation, ambient sound effects, etc. For the actual survey taken by the LAX ATC's, see page 18.

EXCERPTS FROM FFC-LAX LOCAL CONTROLLER SURVEY

FFC = Future Flight Center LAX= Los Angeles International Airport

Print your name: _____ Today's Date: _____

The tower position just worked: _____ Present Local Time: _____

INSTRUCTIONS: Please complete the following survey and then give it to the NASA experimenter. Circle the most appropriate answer for each question and also tell why you chose it. All questions are relative to your experience at LAX under normal operations. Add any other comments/observations on the opposite side if necessary.

A. The amount of coordination required with the ground position on my side of the airport was (circle one)

Much less Less About the same More Much more

If more or less please tell why: _____

B. The amount of coordination required with the local position on the other side of the airport was (circle one)

Much less Less About the same More Much more

If more or less please tell why: _____

C. The coordination with the ground position on my side of the airport was (circle one)

Much easier About the Same More difficult Much more difficult

If easier or more difficult tell why: _____

D. The amount of communication with the pilots was (circle one)

Much less Less About the Same More Much more

If less or more tell why: _____

E. The overall efficiency of this operation was (circle one)

Much less Less About the Same More Much more

If less or more tell why: _____

G. The overall realism of NASA's FFC tower simulation (concentrating on departure operations) with your experiences at LAX under comparable conditions was (circle one number)

1 2 3 4 5

Much poorer About the same As high as I thought possible

H. The overall realism of NASA's FFC tower simulation (concentrating on arrival operations) with your experiences at LAX under comparable conditions was (circle one number)

1 2 3 4 5

Much poorer About the same As high as I thought possible

Now, please rate the realism of NASA's simulation of the LAX environment by using any whole number from one to five.

I. Traffic complexity: ____
J. Overall traffic level: ____
K. Aircraft movements: ____
L. Pilot communication: ____
M. Aircraft taxi speeds: ____
N. Gate-related operations: ____
O. Ambient sound effects in cab: ____

Rating Scale Numbers to Use

1. not at all realistic
2. somewhat realistic
3. realistic
4. very realistic
5. identical to LAX

Instructional Technology Activity

DESCRIPTION

Fasten your seatbelt and get ready for a flight through the U.S. air traffic control system! *Gate to Gate*, a multimedia CD-ROM, takes your students behind the scenes to meet the people who manage air traffic and highlights some of the tools they use everyday. From preflight to landing, students will navigate through the phases of a San Francisco to New York flight and become familiar with the air traffic management facilities that monitor their flight.

Also included with this CD-ROM is the Career Guidance Packet. This downloadable print material introduces students to many of the job opportunities available in air traffic management. The print material is designed to enhance the students' experience with the CD-ROM while engaging them in activities similar to the work of controllers.

To access *Gate to Gate*, contact NASA Central Operation of Resources for Educators at **http://core.nasa.gov**. Additional web activities, on-line resources, and a link to Career Corner, featuring researchers and NASA CONNECT team members, can be found in Dan's Domain on the NASA CONNECT web site.

In addition to *Gate to Gate*, Riverdeep Interactive Learning provides registered NASA CONNECT educators with an interactive instructional technology activity from one of their Destination Math courses. Spanning grades K-12, Riverdeep's Destination Math courses focus on the importance of mastering the underlying skills and concepts of the topics presented and the ability to apply the learned skills and concepts to solve meaningful problems. Destination Math exposes abstract mathematical concepts with a blend of animation, real-life scenarios, and interactive problem solving. The Destination Math activity for this program introduces students to a rectangular coordinate plane by applying the concept with latitude and longitude on a map and can be accessed from **http://connect.larc.nasa.gov/dansdomain.html**.

NATIONAL STANDARDS

Technology (ITEA) Standards

The Nature of Technology

- Develop an understanding of the characteristics and scope of technology.
- Develop an understanding of the core concepts of technology.
- Develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

Technology and Society

- Develop an understanding of the cultural, social, economic, and political effects of technology.

Design

- Develop an understanding of the attributes of design.

Technology (NET) Standards

- Use content-specific tools, software, and simulations to support learning and research
- Apply productivity/multimedia tools and peripherals to support personal productivity, group collaboration, and learning throughout the curriculum
- Design, develop, publish, and present products by using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom
- Select and use appropriate tools and technology resources to accomplish a variety of tasks and solve problems
- Research and evaluate the accuracy, relevance, appropriateness, comprehensiveness, and bias of electronic information sources concerning real-world problems

NATIONAL STANDARDS

Science (NSE) Standards

- Science as Inquiry
  Abilities necessary to do scientific inquiry
- Science in Personal and Social Perspectives
  Risks and benefits
  Science and technology in society

Mathematics (NCTM) Standards

- Model and solve contextualized problems using various representations such as graphs, tables, and equations
- Solve problems involving scale factors, by using ratio and proportion
- Understand that measurements are approximations and understand how differences in units affect precision

INSTRUCTIONAL OBJECTIVES

Students will

- be introduced to many of the personnel who operate the Air Traffic Control System.
- become familiar with the Air Traffic System as it operates today.
- learn how developing sophisticated software tools fit into the Air Traffic Control System.
- navigate through a seven-phase flight from preflight to landing.

Resources

BOOKS, PAMPHLETS, AND PERIODICALS

Beatty, David: *The Human Factor in Aircraft Accidents*, Amazon.com, 1996.

Cushing, Steven: *Fatal Words: Communication Clashes and Aircraft Crashes*, University of Chicago, Chicago, 1994.

Friel, Susan; Rachlin, Sid; and Doyle, Dot: *Navigating through Algebra in Grades 6-8 (with CD-ROM)*, NCTM, 2001. (This book is also available for purchase on **http://nctm.org/publications** under new books.)

Job, MacArthur: *Air Disaster (Volume 3)*, Australian Aviation, 1999.

Krause, Shari Stamford: *Aircraft Safety: Accident Investigations, Analyses and Applications*, McGraw Hill, 1996.

Profitt, Richard: *Systemic Safety Management in the Air Traffic Services*, Euromoney Publishing PLC, 1996.

Reithmaier, Larry W.: *Controlling Pilot Error: Maintenance and Mechanics*, McGraw Hill, 2001.

Stewart, Stanley: *Emergency: Crisis in the Cockpit*, Tab Books, 1991.

Stewart, Stanley: *Flying the Big Jets*, Specialty PR, 2000.

WEB SITES

Aviation Safety / General Information

http://aviation-safety.net/index.shtml
http://www.airsafetyonline.com
http://www.airsafe.com

Aviation Activities and Games

http://www.faa.gov/education/

Interactive Cybercockpit Activities

http://www.msnbc.com/onair/nbc/nightlynews/aviation/cockpit_video.htm
http://www.grouper.com/francois/#AIRSPEED

National Air Traffic Controllers / General Information

http://www.natca.org.htm
http://www.fly.faa.gov/flyFAA/index.html

Live Broadcasts of Air Traffic Controllers

http://www.angelfire.com/mn/PilotInCommand/

Figure This!

Offers Mathematics Challenges that middle school students can do at home with their families to emphasize the importance of a high-quality mathematics education for all.

http://www.figurethis.org

Engineer Girl

Part of the National Academy of Engineering's Celebration of Women in the Engineering project. The project brings national attention to the opportunity that engineering represents to all people at any age, but particularly to women and girls.

http://www.engineergirl.org

GetTech

Through its web site and collateral materials, GetTech helps prepare students in fun ways for tomorrow's great jobs.

http://gettech.org

NASA CONNECT

NASA CONNECT is an annual series of FREE integrated mathematics, science, and technology instructional distance learning programs for students in grades 5-8. Each program has three components: (1) a 30-minute television broadcast, which can be viewed live or taped for later use; (2) an interactive web activity which provides educators an opportunity to integrate technology in the classroom setting; and (3) a lesson guide including a hands-on activity. These three components — television broadcast, web activity, and lesson guide — are designed as an integrated instructional package.

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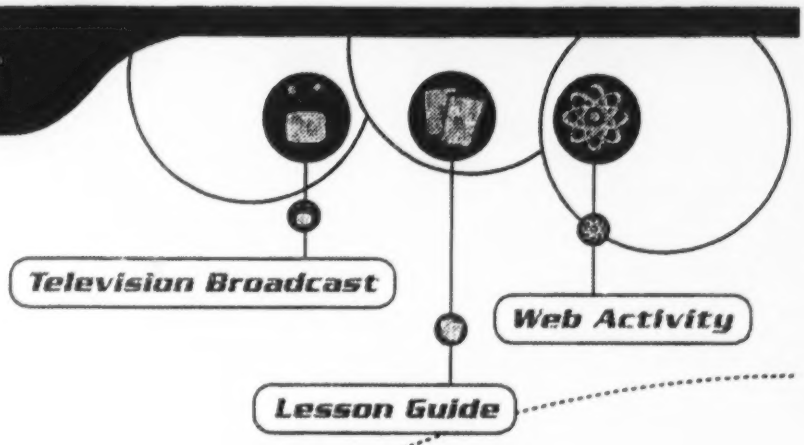

INSPIRE YOUR STUDENTS WITH NASA CONNECT

1 Register

Register for NASA CONNECT online, connect.larc.nasa.gov!

2 Access

NASA CONNECT airs on television, can be down linked from satellite, or obtained as a video. Visit the web site to download the lesson guides and locate the web activities.

3 Integrate

Integrate the television broadcast, hands-on activity, and web activity into your classroom to enhance and extend your curriculum.

Endorsed by nctm.org

connect.larc.nasa.gov

Check on the back for a list of shows in the 2001-2002 NASA CONNECT series and for more information about obtaining the shows.

NASA

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NASA CONNECT
2001-2002 Season

1 Register

2 Access

How can I get the television broadcast?

http://quest.arc.nasa.gov/ltc/special/connect/index.html

http://education.nasa.gov/ercn

http://core.nasa.gov

3 Integrate

MEASUREMENT, RATIOS, AND GRAPHING: Safety First

Starts airing: Sept. 27, 2001, 11 am ET

NASA engineers and researchers use mathematics to maintain high levels of aviation safety and to develop new technologies to meet the growing demands — keeping you safe in tomorrow's skies.

Mathematics: measurement, ratios, graphing

Science: unifying concepts and processes, science as inquiry, science and technology, science in personal and social perspectives

MEASUREMENT, RATIOS, AND GRAPHING: 3, 2, 1.... Crash! (R)*

Starts airing: Oct. 25, 2001, 11 am ET

Crashing planes, skidding tires, and blasting water, NASA engineers work to improve airplane performance and safety.

Mathematics: measurement, ratios, graphing

Science: science and technology, science as inquiry, physical science

GEOMETRY AND ALGEBRA: The Future Flight Equation

Starts airing: Nov. 29, 2001, 11 am ET

NASA engineers and researchers use mathematics to design, develop, and test tomorrow's aircraft.

Mathematics: geometry, algebra

Science: science as inquiry, unifying concepts and processes, science and technology

GEOMETRY AND ALGEBRA: Glow with the Flow (R)*

Starts airing: Dec. 13, 2001, 11 am ET

NASA aerospace engineers use scale models to see how air flows and why materials glow under wind tunnel conditions.

Mathematics: geometry and algebra

Science: physical science, science and technology, science in personal and social perspectives, science as inquiry

DATA ANALYSIS AND MEASUREMENT: Ahead, Above the Clouds (R)*

Starts airing: Jan. 31, 2002, 11am ET

NASA engineers and scientists are developing technologies that will help them predict severe weather.

Mathematics: data analysis and measurement

Science: Earth and space science, physical science, science as inquiry, science and technology, science in personal and social perspectives

PATTERNS, FUNCTIONS AND ALGEBRA: Wired for Space (R)*

Starts airing: Feb. 28, 2002, 11am ET

NASA researchers develop new ways to propel a spacecraft already in orbit without the aid of fuel.

Mathematics: patterns, functions, algebra

Science: physical science, Earth and space science, science as inquiry

DATA ANALYSIS AND MEASUREMENT: Having a Solar Blast

Starts airing: Mar. 28, 2002, 11 am ET

NASA engineers and researchers use mathematics to predict solar storms, anticipate how they will affect the Earth, and improve our understanding of the Sun-Earth system.

Mathematics: data analysis, measurement

Science: science as inquiry, unifying concepts and processes, physical science, Earth and space science, science and technology, science in personal and social perspectives

FUNCTIONS AND STATISTICS: International Space Station: Up to Us (R)*

Starts airing: Apr. 25, 2002, 11 am ET

Ground research + space research = true science as international researchers anticipate working together onboard the International Space Station.

Mathematics: functions, statistics

Science: science and technology, Earth and space science, physical science, science as inquiry

FUNCTIONS AND STATISTICS: Dressed for Space

Starts airing: May 9, 2002, 11 am ET

Building on past space suit technologies, NASA engineers and researchers use mathematics to create the next generation of space suits for the International Space Station and beyond.

Mathematics: functions, statistics

Science: science as inquiry, Earth and space science, physical science, life science, science and technology, science in personal and social perspectives, history and nature of science

*(R) Indicates a repeat show from the 2000-2001 series

Endorsed by

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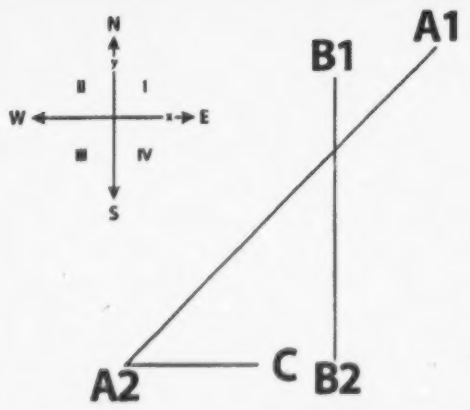

Norbert International Airport
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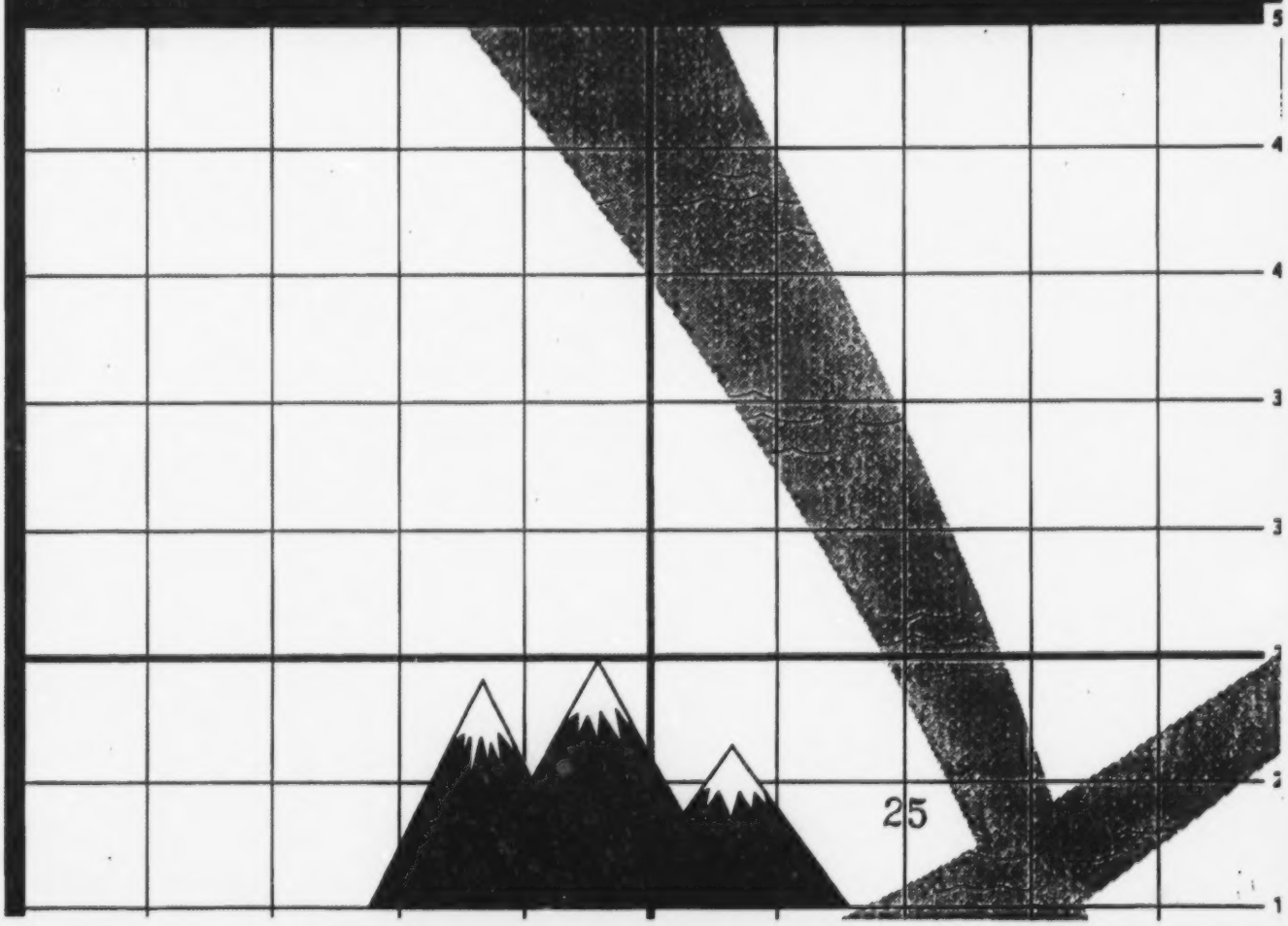

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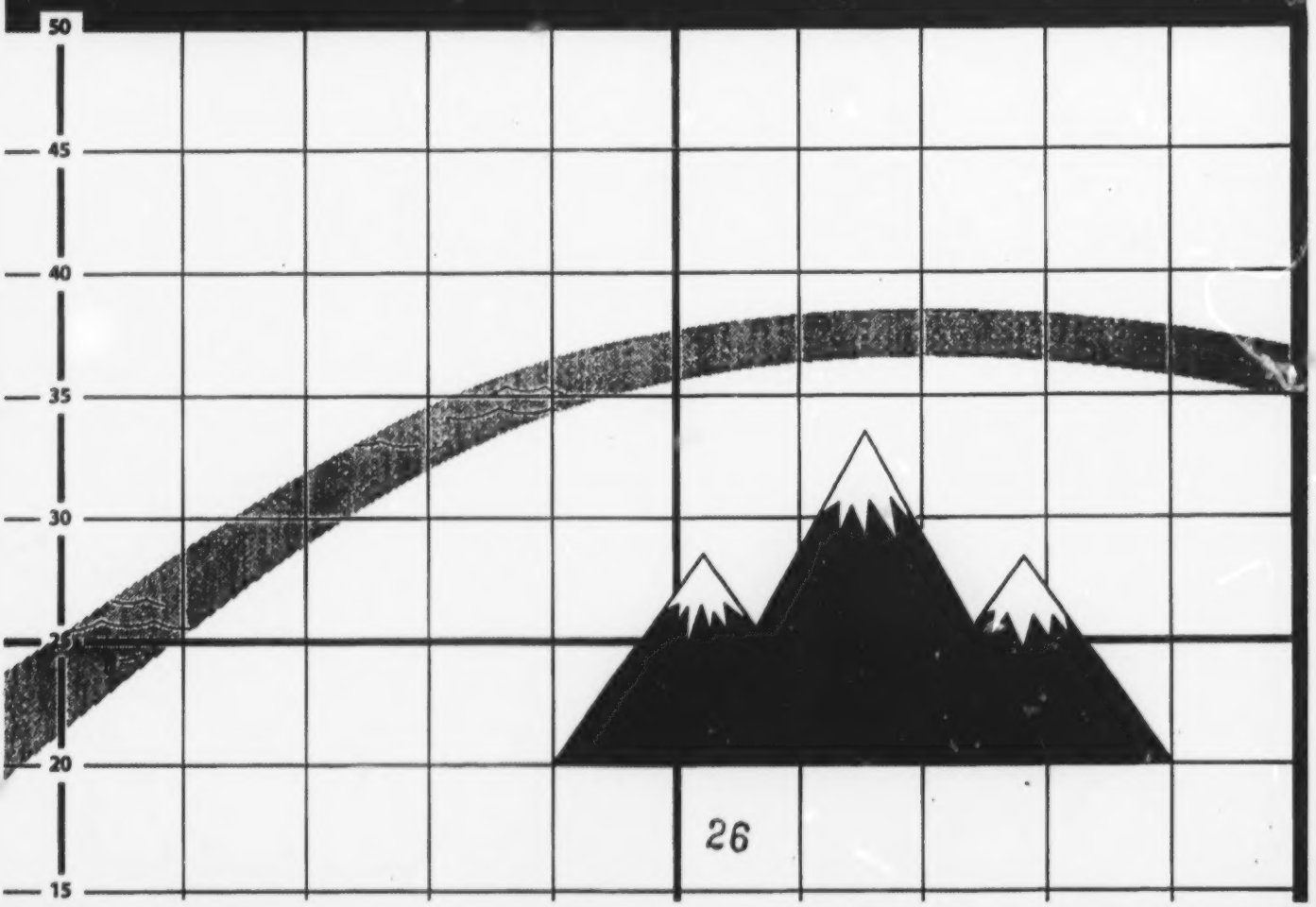

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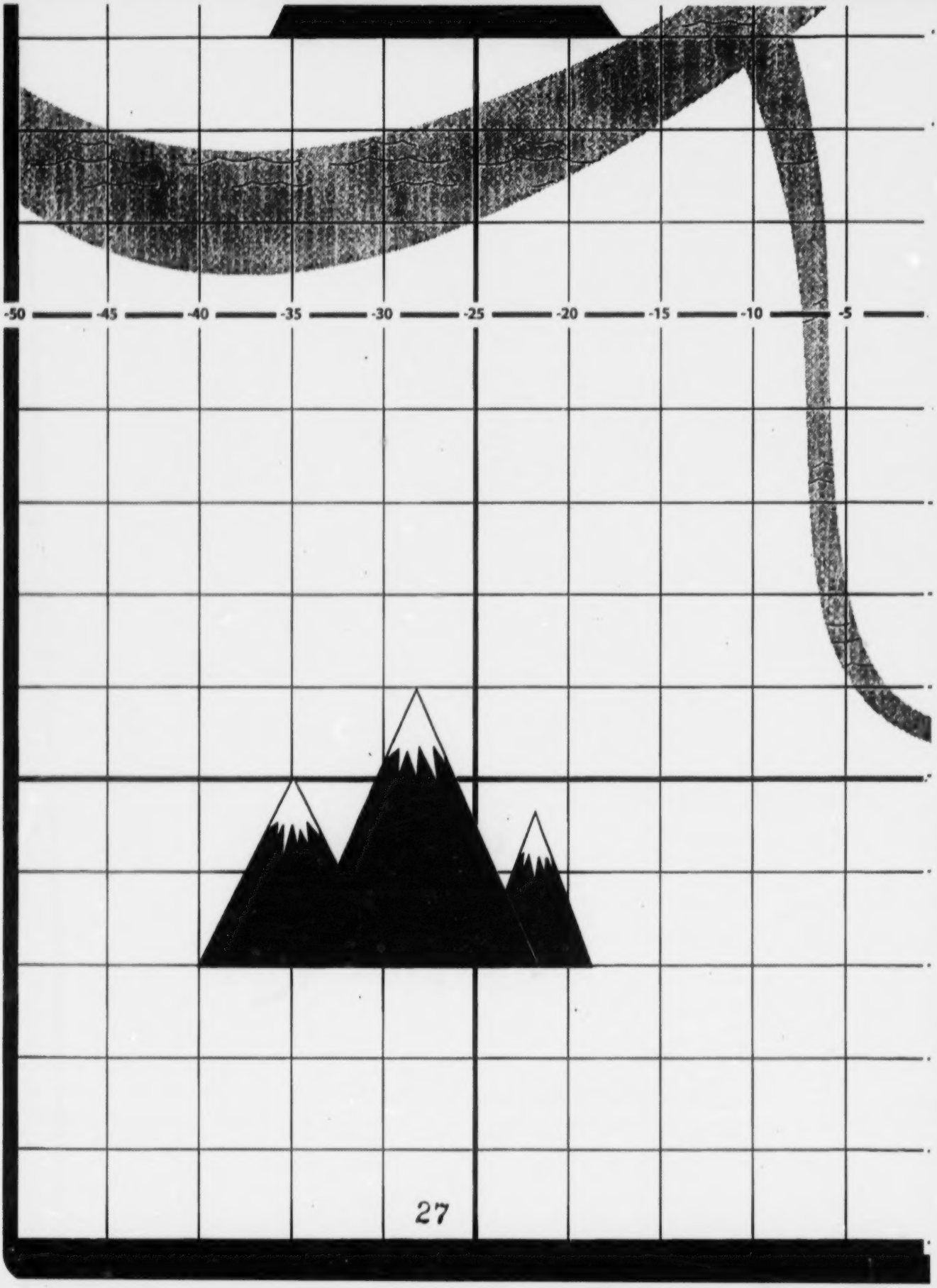
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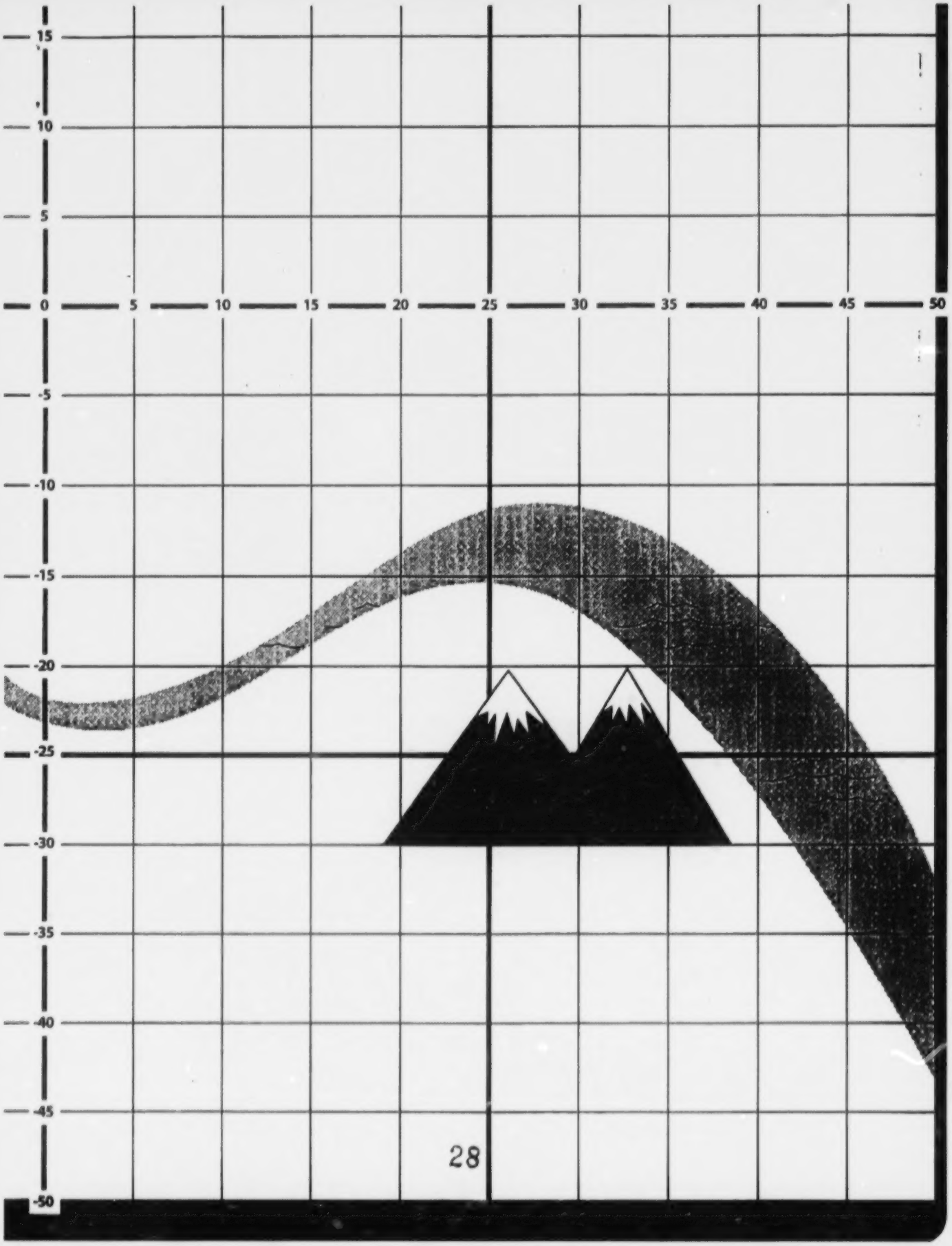
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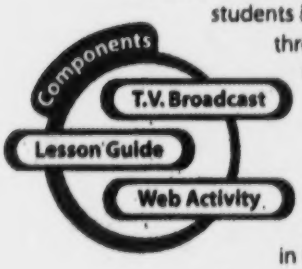
2001-2002 Series Overview

INTRODUCTION TO THE NASA CONNECT SERIES

What is NASA CONNECT?

NASA CONNECT is an annual series of FREE integrated mathematics, science, and technology instructional distance learning programs for students in grades 5-8. Each program has three components: (1) a 30-minute television broadcast, which can be viewed live or taped for later use (see right); (2) an interactive web activity which provides educators an opportunity to use technology in the classroom setting; and (3) a lesson guide describing a hands-on activity. These three components — television broadcast, web activity, and lesson guide — are designed as an integrated instructional package.



NASA CONNECT is FREE to educators. Register on our web site, **http://connect.larc.nasa.gov**. Registered educators will receive, via E-mail, the date of upcoming shows, a show summary, and a PDF version of the lesson guide. NASA CONNECT is a U.S. Government product and is not subject to copyright. There are no fees or licensing agreements. Broadcast and off air rights are unlimited and granted in perpetuity.

Endorsed by the National Council of Teachers of Mathematics (NCTM), NASA CONNECT supports national mathematics, science, and technology standards. The 2001-2002 series uses proportional reasoning as the "integrative thread" that "connects" mathematics topics in each program. NASA CONNECT seeks to establish a "connection" between the mathematics, science, and technology concepts taught in the classroom and the mathematics, science, and technology used everyday by NASA researchers. By demonstrating the processes of creativity, critical thinking, and problem solving skills, NASA CONNECT enhances and enriches mathematics, science, and technology education.

How can I get the television broadcast?

- The shows are broadcast on Ku- and C-band satellite and can be downlinked using the satellite coordinates listed on the NASA CONNECT web site, **http://connect.larc.nasa.gov**.
- NASA CONNECT shows are carried by over 130 PBS stations, Channel One, and on many Cable Access Channels. Check our web site for viewing in your locality.
- Shows are available on the web through NASA's Learning Technologies Channel, **http://quest.arc.nasa.gov/ltc/special/connect/index.html**.
- Video copies of the broadcast can be obtained from the NASA Educator Resource Center in your state, **http://education.nasa.gov/ercn** (p. 8),or from the NASA Central Operation of Resources for Educators, **http://core.nasa.gov** (p. 7).

Educator Services

Get a classroom mentor.

The American Institute of Aeronautics and Astronautics (AIAA) provides classroom mentors to assist educators with the hands-on activities. Every effort will be made to match an educator with an AIAA member who will assist the educators either in person or by E-mail. To request a mentor, e-mail **nasaconnect@aiaa.org** or call Lisa Bacon at (703) 264-7527 at least four weeks prior to conducting the student activity.

Free e-mail account

If you do not currently have an e-mail account, free accounts are available for educators at ePALS Classroom Exchange. Simply visit **www.epals.com** and click on "Step 1: Join our online community" to register. Registration takes only two minutes and allows you to access E-mail tools and to create a searchable profile for your class. Include the term "NASA CONNECT" or "AIAA Mentor" in your profile description and you will be able to find and communicate with colleagues also using the NASA CONNECT program.

NASA CONNECT 2001-2002 Theme

The 2001-2002 NASA CONNECT series uses the five Strategic Enterprises as its organizing theme: Aerospace Technology, Earth Science, Human Exploration and Development of Space, Space Science, and Biological and Physical Research. For more information on these Enterprises visit **http://www.nasa.gov/enterprises.html.** This theme forms the creative basis for the series of nine programs; four new programs and five repeat programs from the 2000-2001 NASA CONNECT series.

2001-2002 NASA CONNECT PROGRAMS

MEASUREMENT, RATIOS, AND GRAPHING: Safety First

Starts airing: Thursday, September 27, 2001, 11 am ET

NASA engineers and researchers use measurement, ratios, and graphing to maintain high levels of aviation safety and to develop new technologies to meet the growing demands — keeping you safe in tomorrow's skies.

Mathematics: measurement, ratios, graphing

Science: unifying concepts and processes, science as inquiry, science and technology, science in personal and social perspectives

NASA Research: Aviation Safety, Virtual Flight Tower

MEASUREMENT, RATIOS, AND GRAPHING: 3, 2, 1.... Crash! (R)*

Starts airing: Thursday, October 25, 2001, 11 am ET

Crashing planes, skidding tires, and blasting water, NASA engineers work to improve airplane performance and safety.

Mathematics: measurement, ratios, graphing

Science: science and technology, science as inquiry, physical science

NASA Research: Aircraft Landing Dynamics Facility, Impact Dynamics Research Facility

GEOMETRY AND ALGEBRA: The Future Flight Equation

Starts airing: Thursday, November 29, 2001, 11 am ET

NASA engineers and researchers use geometry and algebra to design, develop, and test tomorrow's aircraft.

Mathematics: geometry, algebra

Science: science as inquiry, unifying concepts and processes, science and technology

NASA Research: Advanced Vehicle Concepts, Hyper X

GEOMETRY AND ALGEBRA: Glow with the Flow (R)*

Starts airing: Thursday, December 13, 2001, 11 am ET

NASA aerospace engineers use scale models to see how air flows and why materials glow under wind tunnel conditions.

Mathematics: geometry and algebra

Science: physical science, science and technology, science in personal and social perspectives, science as inquiry

NASA Research: Flow Visualization, Blended Wing Body

DATA ANALYSIS AND MEASUREMENT: Ahead, Above the Clouds (R)*

Starts airing: Thursday, January 31, 2002, 11am ET

Predicting severe weather, tracking clouds, and monitoring pollutants in the air, NASA engineers and scientists are developing technologies to collect data that will help them better understand Earth's climate.

Mathematics: data analysis and measurement

Science: Earth and space science, physical science, science as inquiry, science and technology, science in personal and social perspectives

NASA Research: Geostationary Imaging Fourier Transform Spectrometer (GIFTS)

PATTERNS, FUNCTIONS AND ALGEBRA: Wired for Space (R)*

Starts airing: Thursday, February 28, 2002, 11am ET

NASA researchers develop new ways to propel a spacecraft already in orbit without the aid of fuel.

Mathematics: patterns, functions, algebra

Science: physical science, Earth and space science, science as inquiry

NASA Research: Propulsive Small Expendable Deployer System (ProSEDS)

***(R) indicates a repeat show from the 2000-2001 series**

DATA ANALYSIS AND MEASUREMENT: Having a Solar Blast

Starts airing: Thursday, March 28, 2002, 11 am ET

NASA engineers and researchers use data analysis and measurement to predict solar storms, anticipate how they will affect the Earth, and improve our understanding of the Sun-Earth system.

Mathematics: data analysis, measurement

Science: science as inquiry, unifying concepts and processes, physical science, Earth and space science, science and technology, science in personal and social perspectives

NASA Research: SOlar Heliospheric Observatory (SOHO), Imager for Magnetopause-to-Aurora Global Exploration (IMAGE)

FUNCTIONS AND STATISTICS: International Space Station: Up to Us (R)*

Starts airing: Thursday, April 25, 2002, 11 am ET

Ground research + space research = true science as international researchers anticipate working together onboard the International Space Station.

Mathematics: functions, statistics

Science: science and technology, Earth and space science, physical science, science as inquiry

NASA Research: International Space Station Program, Virtual International Space Station

FUNCTIONS AND STATISTICS: Dressed for Space

Starts airing: Thursday, May 9, 2002, 11 am ET

Building on past space suit technologies, NASA engineers and researchers use functions and statistics to create the next generation of space suits for the International Space Station and beyond.

Mathematics: functions, statistics

Science: science as inquiry, Earth and space science, physical science, life science, science and technology, science in personal and social perspectives, history and nature of science

NASA Research: Advanced Suit Development, Radiation Analysis

***(R) indicates a repeat show from the 2000-2001 series**

NASA CONNECT INSTRUCTIONAL DESIGN

Each program in the 2001-2002 NASA CONNECT series is designed to enhance and enrich the teaching of specific mathematics, science, and technology concepts. The NASA CONNECT series can be easily integrated into an existing curriculum or used to introduce or reinforce a curriculum topic, objective, or skill. These instructional programs demonstrate the "how to" and the "real world" application and integration of mathematics, science, and technology. NASA CONNECT has two objectives:

1. Students will be able to make connections between the mathematics, science, and technology taught in their classrooms and the real world applications by observing NASA researchers.
2. Students will be able to increase their understanding of mathematics, science, and technology concepts through interactive activities.

Each NASA CONNECT program models an instructional lesson design which includes an anticipatory set, explanation, questioning strategy, and interactive activities. The accompanying lesson guide provides a program summary and objectives, background information, relevant national mathematics, science, and technology standards, step-by-step instructions for conducting the activities, print and on-line resources, and suggestions for extending the activities.

Jackie Chan introduces GEOMETRY AND ALGEBRA: Glow with the Flow.

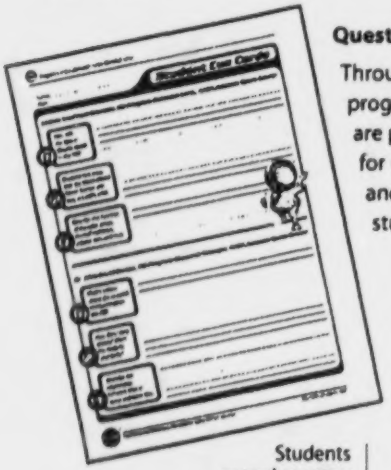
Anticipatory Set

Hosts and celebrity guests focus student attention, connect the program to past,

present, or future learning, and visually and verbally present the learning objectives.

Explanation

NASA engineers, scientists, and other expert guests illustrate the application and relevance of mathematics, science, and technology to the workplace. The connection is further established by introducing students to the tools and methods used by NASA researchers and other experts. Their contributions form the basis for the learning objectives.



Students record answers on Cue Cards.

Questioning strategy

Throughout the program, questions are posed to check for understanding and to give students time to process the mathematics, science, and technology concepts presented. Students record their answers on Cue Cards that are provided in the lesson guide.

Interactive Activities

The hands-on and web activities are based on national mathematics, science, and technology standards. These two interactive activities provide students the opportunity to connect the mathematics, science, and technology concepts learned in the classroom to the research presented by NASA researchers, engineers, and scientists.

NASA CONNECT Teaching Strategy

INTRO TO NASA CONNECT TEACHING STRATEGY

The model proposed to educators through the NASA CONNECT series introduces students to inquiry and the process of searching for patterns and relationships. The six-step teaching strategy is designed to encourage the development of higher order cognitive skills and a more active mental engagement with the television broadcast. Following this strategy enables students to make stronger connections between the television broadcast, the activities, and appropriate mathematics, science, and technology concepts.

The six-step strategy includes reflective discussion, student involvement, dialogue notes, the hands-on activity, journal writing, and the web activity. The strategy, consistent with constructivist theory, promotes rich discourse among students. The proposed format is flexible and effective in enhancing students' understanding of complex mathematics, science, and technology concepts.

STEPS IN NASA CONNECT TEACHING STRATEGY

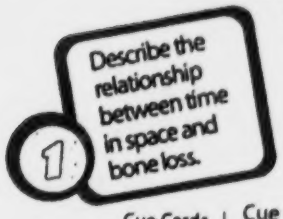
Step 1: Reflective Discussion

Prior to viewing the NASA CONNECT television broadcast or videotaped copy, list and discuss questions and preconceptions that students have about the program topic. Keep these questions on the board during the show. In addition to helping students prepare for the program, these questions can also serve as a pretest for assessment purposes. The following is a sample of teacher-directed questions:

1. What role does mathematics play in science?
2. What kinds of mathematics, science, and technology do NASA experts use in their research?
3. What other skills are necessary to conduct research?
4. Of what value are collaborations and partnerships in conducting research?

Step 2: Student Involvement

NASA CONNECT is not designed for passive viewing and actively engages students throughout the program. The following suggestions are provided to help educators focus student attention on the major concepts presented in the show.



Cue Cards help students stay focused.

Cue Cards have selected questions that focus on the critical elements in each show segment. Educators should copy the Cue Cards from the lesson guide and distribute them prior to viewing the show. Students are encouraged to take notes during the show and answer the questions on the cards.

Norbert's Pause

When viewing a videotaped version of NASA CONNECT, educators have the option to use Norbert's Pause, which gives students an opportunity to reflect, answer, and discuss the Cue Card questions. Norbert, the animated cohost of NASA CONNECT, appears with a remote to indicate an appropriate time to pause the videotape.

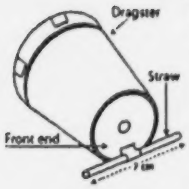
Step 3: Dialogue Notes

Immediately following the show, students should spend five to ten minutes reviewing the questions in "Step 1: Reflective Discussion Section." Educators should ask students to give examples from the show that support their responses to each question.

Review the Cue Cards with students. Educators should ask students to share what they recorded and learned from each guest and NASA researcher. Students should also discuss what they believe are the important mathematics, science, and technology concepts these individuals use in their work.

Step 4: Hands-On Activity

Students learn from direct teaching, engaging in classroom discussion, conducting research, and taking notes. The teacher-tested, hands-on activity is designed to enhance mathematics, science, and technology concepts. Students are assigned to cooperative groups and use everyday objects to complete the activity.



Hands-on activities with step-by-step instructions and diagrams are in every lesson guide.

When using the NASA CONNECT hands-on activity, refer to the lesson guide. Introduce students to the vocabulary, guide students toward connections, explore possible misconceptions associated with the topic, conduct the activity, and conclude by analyzing the data. Finally, have students relate the results of the activity to the NASA research presented in the show.

Step 5: Journal Writing

Journal writing supports students' reflective thinking processes. Students should reflect on what they learned from the show and from their own experimentation. Educators can ask students questions that relate to the application of mathematics, science, and technology concepts presented in the show to real-life situations. Educators might use journal questions to assess student understanding of the concepts presented in the lesson guide.

Step 6: Web Activity

Dan Geroe, NASA CONNECT co-host

Dan's Domain, located on the NASA CONNECT web site, features an interactive web activity for each program that supports and enhances the mathematics, science, and technology content presented in each show. Dan's Domain also provides links to other relevant NASA sites and a Career Corner that features program guests sharing information about their jobs at NASA. Teachers are encouraged to visit the Lab Manager section of Dan's Domain to receive guidance in using the web activities as part of the total NASA CONNECT learning experience (television broadcast/lesson guide/web activity). In the Lab Manager, there is a special link to additional mathematics activities produced by Riverdeep Interactive Learning, a new NASA CONNECT program partner.

The NASA CONNECT web site, **http://connect.larc.nasa.gov**, includes information about the current season and past seasons of NASA CONNECT, broadcast dates and times, and additional student activities. The web site also establishes a connection between the classroom and the family. Educators may send home the NASA CONNECT web address to encourage parents to explore the web activities with their children.

NASA Resources for Educators

NASA's Education Home Page **(http://education.nasa.gov)** serves as the cyber-gateway to information regarding educational programs and services offered by NASA for educators and students across the United States and provides specific details and points of contact for all of NASA's educational efforts and Field Center Offices. Those using the site will have access to a comprehensive overview of NASA's educational programs and services, as well as home pages offered by NASA's four areas of research and development.

NASA Langley Research Center, Office of Education **(http://edu.larc.nasa.gov)** offers a wide variety of opportunities for educators at all levels of instruction. The Office of Education seeks to enhance the teaching of mathematics, science, and technology through its distance learning programs, all of which are described on the web site. Educators can also search NASA educational resources for the classroom, including activities, curriculum enhancing projects, and equipment. From this site, you can link to our NASA CONNECT web site.

NASA Spacelink **(http://spacelink.nasa.gov)** is one of NASA's electronic resources that is specifically developed for use by the education community. This comprehensive electronic library offers teacher guides, wall sheets, listings of videos, computer software, and other materials that have been developed to meet national education standards. Educators can search specific curriculum materials by grade level and subject matter. Current and historical information related to NASA's aeronautic and space research can be found on Spacelink. Links to NASA Educator Resource Centers (ERCs), the Central Operations of Resources for Educators (CORE), news releases, current state reports on agency projects and events, and television broadcast schedules for NASA Television are also provided.

Quest **(http://quest.nasa.gov)** is the home of NASA's K-12 internet initiative. This electronic resource specializes in providing programs, materials, and opportunities for teachers and students to use NASA resources as learning tools to explore the Internet. One of its unique projects is Sharing NASA, a series about on-line, interactive units where students can communicate with NASA scientists and researchers to experience the excitement of real science in real time.

The Learning Technologies Channel (LTC) **(http://quest.nasa.gov/ltc/)** is a NASA location on the Internet that allows you to participate in on-line courses and to remotely attend some NASA workshops and seminars. A primary focus of the LTC is to broaden the uses of the Internet to include in-service teacher training and to bring new internet experiences into the classroom.

NASAexplores **(http://NASAexplores.com/)** provides science, mathematics, and technology lessons that are published weekly. NASAexplores gives teachers timely educational content based on current research, development, and related events. The web site provides an e-mail subscriber list service to notify subscribers of weekly content. Teachers sign up to receive e-mail notices linking them directly to the web site where the lessons, along with related resources and materials, are posted. Teachers without e-mail can also access the lessons by visiting the NASAexplores web site.

NASA CORE, Central Operation of Resources for Educators **(http://core.nasa.gov)** is a worldwide distribution center for NASA multimedia educational materials. Educational materials include videotape programs, slide sets, and computer software. For a minimal fee, NASA CORE will provide educators with materials through its mail order service. A free NASA CORE catalog is available.

NASA CORE
15181 State Route 58 South, Oberlin, OH 44074,
phone: (440) 775-1400, fax: (440) 775-1460,
E-mail: nasaco@leeca.org

EDUCATOR RESOURCE CENTER NETWORK

The NASA Educator Resource Center Network (ERCN) is composed of Educator Resource Centers (ERCs) located on or near all NASA field centers, colleges, museums, or other nonprofit organizations. These centers provide educators with inservice and preservice training, demonstrations, and access to NASA instructional products.

For a list of ERCs in your state, visit the NASA Educator Resource Center Network, **http://education.nasa.gov/ercn**. Educators may also contact one of the ERCs at the following NASA Centers.

AK, Northern CA (southern-most counties of Inyo, Kings, Monterey, Tulare), HI, ID, MT, NV, OR, UT, WA, WY
NASA Ames Educator Resource Center
Mail Stop 253-2
Moffett Field, CA 94035-1000
(650) 604-3574
http://amesnews.arc.nasa.gov/erc/erchome.html

AZ, Southern CA (northern-most counties of Kern, San Bernadino, San Luis Obispo)
NASA Dryden Educator Resource Center
45108 North Third Street East
Lancaster, CA 93535
(661) 948-7347
http://www.dfrc.nasa.gov/trc/ERC

CA
NASA JPL Educator Resource Center
Village at Indian Hills Mall
1460 East Holt Blvd., Suite 20
Pomona, CA 91767
(909) 397-4420
http://eis.jpl.nasa.gov/eao/

CT, DE, DC, ME, MD, MA, NH, NJ, NY, PA, RI, VT
NASA Goddard Educator Resource Center
Mail Code 130.3
Greenbelt, MD 20771
(301) 286-8570
http://pao.gsfc.nasa.gov/gsfc/educ/trl/welcome.html

VA's and MD's Eastern Shore
NASA Wallops Educator Resource Center
Education Complex - Visitor Center
Building J-17
Wallops Island, VA 23337
(757) 824-2298
http://www.wff.nasa.gov/pages/visitor.html

FL, GA, Puerto Rico, Virgin Islands
NASA Kennedy Educator Resource Center
Mail Code ERC
J.F. Kennedy Space Center, FL 32899
(321) 867-4090
http://www-pao.ksc.nasa.gov/kscpao/educate/edu.htm

CO, KS, NE, NM, ND, OK, SD, TX
Johnson Space Center
1601 NASA Road One
Houston, TX 77058
(281) 244-2129
http://www.spacecenter.org/educator_resource.html

KY, NC, SC, VA, WV
NASA Langley Educator Resource Center
Virginia Air and Space Center
600 Settlers Landing Road
Hampton, VA 23669
(757) 727-0900, ext. 757
http://www.vasc.org/erc

IL, IN, MI, MN, OH, WI
NASA Glenn Educator Resource Center
21000 Brookpark Road, MS 8-1
Cleveland, OH 44135
(216) 433-2017
http://www.grc.nasa.gov/WWW/PAO/html/edteachr.htm

AL, AR, IA, LA, MO, TN
NASA Marshall Educator Resource Center
U.S. Space and Rocket Center
One Tranquility Base
Huntsville, AL 35807
(256) 544-5812
http://erc.msfc.nasa.gov

MS
NASA Stennis Educator Resource Center
Building 1200
Stennis Space Center, MS 39529
(228) 688-3338
http://education.ssc.nasa.gov/htmls/trc/trc.htm

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